



Important Pests of Apricots

HAROLD F. MADSEN
by LESTER B. McNELLY



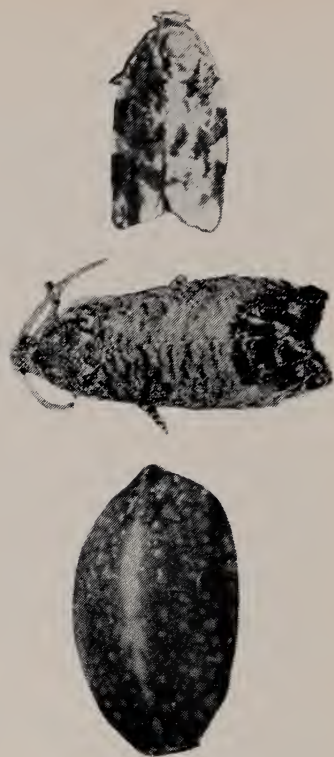
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Some of the pesticides used in the studies summarized in this publication have not yet been registered with the proper federal and state agencies. For this reason, and because control programs change from season to season, specific suggestions for insecticides or acaricides are not included. Spray program recommendations are available each year at your farm advisors' office or the University Public Service office.

Important Pests of Apricots

A Summary of Research



HAROLD F. MADSEN and LESTER B. McNELLY

A pest control program for apricots presents special problems because apricots are a short season crop as compared with other deciduous fruits. Proper timing of the control program, therefore, is of critical importance. Such timing can be achieved only by an understanding of the life cycle of the specific apricot pest.

In this publication each major pest of apricots is discussed in the light that various research studies have thrown upon identification, life cycles, and economic damage. The biology and control data established by these studies have been summarized in order to provide the reader with a basic approach to intelligent control of the pests. Discussion of control itself is limited to those natural factors which regulate the abundance of the pest, or which provide a basis for the proper timing of necessary artificial control measures.

DECEMBER, 1961

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Submitted for publication May 19, 1961

FOLIAGE FEEDERS

SPIDER MITES

While apricots are not commonly attacked by spider mites, there are occasional reports of apricot orchards being infested with one or more of three common species of these pests. It is recognized that the two-spotted mite, *Tetranychus telarius* (Linn.), is a pest of apricots. Occasionally the brown mite, *Bryobia arborea* Morgan and Anderson, is noted in apricot orchards in sufficient numbers to do leaf damage. The Pacific mite, *Tetranychus pacificus* (McG.), does minor damage to apricots in the interior valleys, and Pritchard and Baker (1952) list apricot as a host of this mite.

The European red mite, *Panonychus ulmi* (Koch) has also reportedly infested apricots.

TWO-SPOTTED MITE

Field Identification

The mature female is greenish to yellow in color with a conspicuous dark spot on each side of the body. These spots will sometimes be so prominent that the mite appears almost black. Overwintering females are bright orange and lack the black spots.

Seasonal Life History

On fruit tree hosts, the two-spotted mite overwinters as an adult, either beneath bark scales or under litter on the ground. In warmer seasons, the mites remain active on cover crop plants during the winter. The pale yellow to greenish adults appear on the orchard weeds in May or June. The two-spotted mite feeds on the cover crop until the weather turns warm and the cover crop begins to dry out or is disked under. The mites then move up into the tree, first attacking foliage near the trunk and main limbs.

Eggs are laid in the webbing formed on the leaves. Many generations are produced during the summer.

Injury

The two-spotted mite may injure apricot leaves during the summer and early fall. Infested leaves become brown and partial defoliation may occur if high numbers of mites are present.

Injury to apricot fruits by mites had not been reported until the spring of 1959. In June an infestation of the two-spotted mite was noted in an apricot orchard in Santa Clara County. The mites congregated on the fruit, particularly on those near the main scaffold limbs of the trees. In contrast to the usual situation, there was a very light infestation on the leaves. The population was severe enough to cause surface blemishes to the fruit which were similar to fog spot described by Hesse (1952) (fig. 1).

Control

Control of the two-spotted mite may be obtained by the use of one of several acaricides available for this purpose. Specific directions for mite control on apricots have not been developed. If it is necessary to treat prior to harvest, a material which will leave a minimum amount of toxic residue should be chosen.

PACIFIC MITE

Field Identification

Active females closely resemble the two-spotted mite and are greenish to yellowish in color with a large dark spot on each side near the center of the body and another pair of dark spots near the caudal end. The overwintering females are bright orange in color. The mites produce copious amounts of silk webbing and the translucent round eggs are laid within the webbing on the surface of the leaves.

Seasonal Life History

The Pacific mite overwinters as mature females. Hibernation takes place under

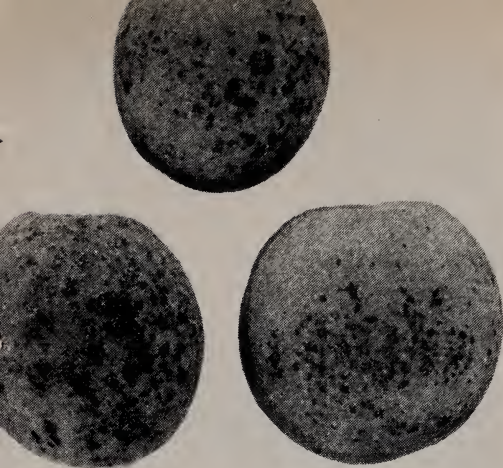


Figure 1. Two-spotted mite damage to apricot fruit.

the bark of the tree or in the litter on the ground. In the spring the mites migrate up into the tree. Development from egg to adult takes about ten days during ideal conditions. There are several generations each season, and the mites build up rapidly during periods of hot weather.

Injury

This species feeds on the undersides of the leaves, and high numbers may cause browning and defoliation. The web spun by the adult collects dust and impairs the normal leaf functions.

Control

Methods used for two-spotted mite control can also be used against the Pacific mite.

BROWN MITE

Field Identification

The mature adult is brown to dull green in color with the body flattened above. The front legs of the adult female are quite long and extend forward when the mite is at rest. This species spins no web. Newly hatched larvae are bright scarlet. The overwintering egg is bright red, spherical in shape and lacks a dorsal stipe. This latter structure is characteristic of European red mite eggs which are otherwise similar in appearance to the eggs of the brown mite.

Seasonal Life History

Overwintering eggs are located around roughened areas on the twigs and limbs. The egg hatch prior to the bloom stage of the tree and the immature mites are found on the opening leaves and flower parts. Later generations attack the leaves. As described by Summers (1952), the mite has alternating phases of residence, spending the day on the woody parts and moving to the leaf surfaces in response to changes of temperature and sunlight.

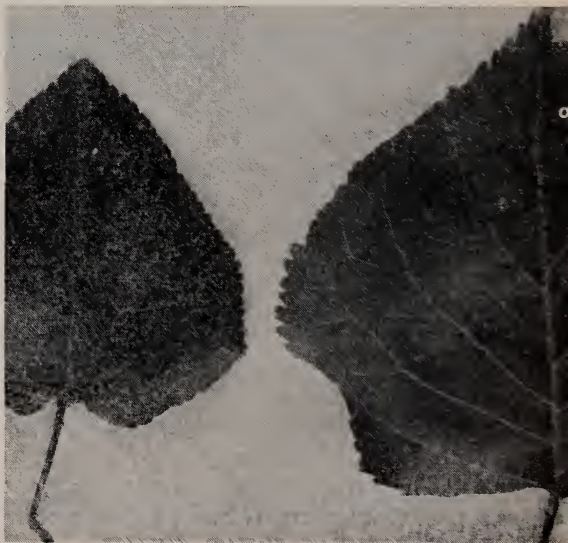
Injury

A peppery or stippled appearance of the leaves is characteristic of brown mite attack (fig. 2). Heavy infestations can cause chlorosis, but defoliation does not occur. Typically, the basal leaves on a shoot exhibit the most severe damage.

Control

Since the mite overwinters as an egg on the tree, dormant sprays directed against the egg stage are effective. The eggs are often difficult to wet with spray because of their location in rough bark areas, but thorough coverage is necessary to obtain satisfactory control.

Figure 2. Apricot leaf on left shows the stippled injury characteristic of brown mite.



APHIDS

A number of aphids are found on apricot. Essig (1958) lists the water lily aphid, *Rhopalosiphum nymphaeae* (L.), and the green peach aphid, *Myzus persicae* (Sulz.) as occurring on apricot, but neither species is of economic importance. Smith (1937) states that the mealy plum aphid, *Hyalopterus arundinis* (F.) attacks apricots in subtropical regions but confines its attack to plums and prunes in California. Infestations of mealy plum aphid have been observed on apricots, especially in Contra Costa County during the past several years, and infestations are occasionally severe enough to require control.

MEALY PLUM APHID

Field Identification

The summer forms of the mealy plum aphid are light green in color and covered with a white powery wax. They are found on the undersides of the leaves and can cover entire leaf surfaces when populations are high.

Seasonal Life History

The aphids spend the winter in the egg stage on the tree. Eggs are laid near the bases of buds or between the buds and twigs. They hatch early in spring, prior to the bloom stage of tree development, and the first individuals to appear

are called "stem mothers." These forms feed upon the opening flowers and leaves; later generations infest only the leaves. Several generations are produced on the primary host until warm weather occurs in June and July. At this time, winged females are produced and these fly to cattails, the alternate host. In October and November, winged aphids are produced on the secondary host. These fly back to the primary host and give rise to sexual males and females which mate and lay the overwintering eggs.

Injury

Although some stunting of growth results from aphid attack, the principal injury is caused by copious honeydew produced by the aphids. The honeydew drips to the foliage and fruit, and a black fungus which grows in the honeydew gives both leaves and fruit an unsightly appearance.

Control

Chemical control of the mealy plum aphid on apricot is seldom necessary. Infestations are usually restricted to individual limbs, and it is rare that entire trees will be attacked. A number of predators and parasites are known to attack the aphid, and they can often hold them below economic levels. If chemical control is necessary, spot treatment with a suitable aphicide will suffice.

FOLIAGE AND FRUIT FEEDERS

EUROPEAN EARWIG

The European earwig *Forficula auricularia* (L.) attacks apricots in the coastal regions, particularly in the San Francisco Bay region. It is a common pest in backyards, attacking vegetables, flowers, and ornamentals.

Field Identification

The earwig passes the egg stage and part of its nymphal and adult stages sev-

eral inches below the soil surface.

The immature stages are wingless but otherwise have the same appearance as the adult. They are smaller, being less than $\frac{3}{8}$ of an inch in length, and brownish gray in color. Immature earwigs are creamy white just after moulting, but within a short time the cuticle hardens and darkens in color.

An earwig passes through four growth stages, or instars, and the mature earwig is winged, shiny brown in color, and has



Figure 3. Male and female European earwig.

a pair of forceps which are located on the posterior end of the abdomen. It is slightly over $\frac{1}{2}$ inch long exclusive of the forceps. The forceps of the male are curved and those of the female are almost straight; this fact serves to distinguish the sexes (fig. 3).

Seasonal Life History

Investigations by Crumb, Eide and Bonn (1941) have shown that earwigs in the Washington state coastal region undergo the following life cycle: Adults enter the soil in the fall to form cells which are usually occupied by a pair. In January the males leave and the females deposit the eggs in the cells.

The females are semisocial and they remain with the young throughout most of the first and second instar stages. In late April the female opens the earthen cell and the nymphs emerge. After reaching maturity, adults feed for several weeks. In the latter part of May or early

June a small percentage of males and females re-enter the ground to lay eggs for a second brood. The nymphs of this brood appear in late July.

Observations in California indicate that in the San Francisco Bay region the life cycle is slightly earlier than in the northwest. There are two broods, and the second (July) brood is much smaller in number than the initial (April) brood. Earwigs are gregarious and will congregate in large numbers. Crumb, Eide and Bonn (1941) state that earwigs prefer above-ground hiding places, and observations in California support this point. After leaving the ground in April they prefer to hide in deep crevices or under loose bark on trees. Excavations made by termites in apricot trees are favorite hiding places.

Injury

Earwigs damage both leaves and fruit of apricots. Although omnivorous, ear-



Figure 4. Foliage damage to apricots due to earwig feeding.

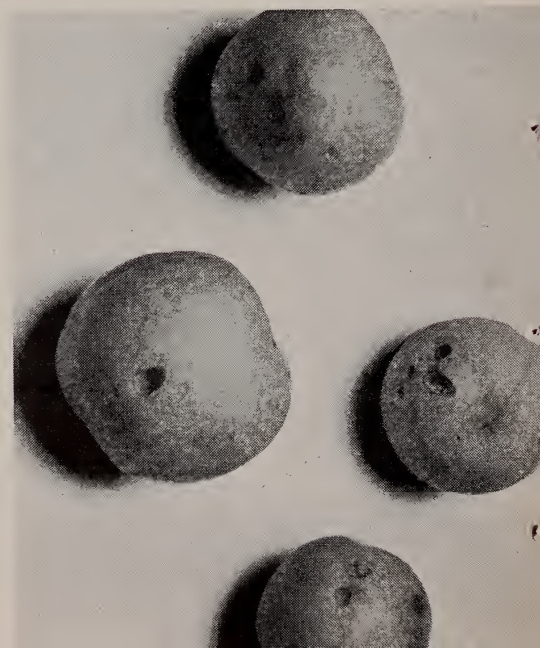
wigs feed primarily on plant tissue in the coastal climates. Leaf damage is unsightly but of minor concern on mature trees (fig. 4). On young seedlings, however, the earwig feeds on the shoot tips and damage may be extensive, as stunting of normal growth may occur.

Damage to the fruit is characterized by shallow irregularly shaped feeding areas on the surface (fig. 5). On occasion, an earwig will bore through and feed on the flesh near the pit (fig. 6). Thus it finds both shelter and food and often remains within the apricot. Earwigs will also enter any area damaged by other pests, such as birds or caterpillars, and are often found in cracks formed during the growth of the fruit.

The earwig is nocturnal and feeds at night. As a result, damage often goes unnoticed until harvest time. Although winged, earwigs rarely fly. Infestations

in apricot orchards are, therefore, localized and spread slowly.

Figure 5. Typical earwig feeding scars on the apricot fruit surface.



Control

It has been the practice of growers in the coastal regions to dust the trunks of the trees with a residual insecticide several weeks before harvest. This practice gives partial control only, because most of the earwigs are located above the treated portion of the tree.

Control Studies—1958

Studies were conducted during 1958 in a Santa Clara Valley apricot orchard. The orchard selected had the trunks and main limbs damaged by termites, excavations affording hiding places for earwigs.

Single tree plots were used with five replications for each treatment. Only infested trees were selected for the experiment. Materials and dosages were as follows: dieldrin (1.5 lbs. per gallon emulsion concentrate), 6 pints; Endrin (1.6 lbs. per gallon emulsion concentrate), 4 pints; Sevin, 50 per cent wettable, 8 pounds; and Thiodan, 25 per cent wettable, 8 pounds. All dosages were amounts per 100 gallons of water.

The plots were evaluated by counting the number of living and dead earwigs and results were as follows: Sevin gave 93 per cent control and, in addition, acted as an irritant; earwigs left their hiding places shortly after treatment. The other materials gave control ranging from 49 to 78 per cent, but none was as effective as Sevin.

Control Studies—1959–1960

In 1959 and 1960 experiments were conducted on walnuts rather than apricots because an extremely heavy earwig population was encountered in a mature Franquette orchard in the Santa Clara Valley. Materials used were the same as employed in 1958 except that Endrin was not included. Dosages used were one-half those employed the previous season.

Plots were evaluated by placing 3-inch-wide cement collars 5 feet from the ground on the test trees. A skirt of light

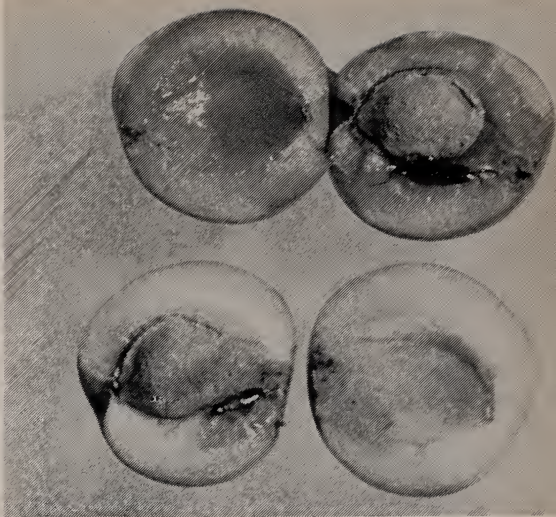


Figure 6 (Right). Earwigs feeding near the pit of an apricot.

weight tar paper was affixed to the lower half of the collar to provide a hiding place for earwigs. A ring of sticky polybutene was placed above the paper to prevent earwigs from moving farther up the trees. When a population count was made, a white sheet was placed beneath the tree and the tar paper was removed. The exposed earwigs were counted on the tree and those that fell on the sheet were included in the count. Populations above 100 per tree were estimated rather than counted. The disturbed earwigs moved so rapidly that it was not possible to accurately count high numbers.

The materials were applied to the trunks of the trees with sufficient gallonage to drench the bark. Table 1 shows the materials used, dosage, and earwig counts. These data indicate that Sevin provided the best control of the European earwig, thus confirming the results obtained in 1958. Trees in the Dieldrin and Thiodan plots were resprayed with Sevin at varying dosages after the early June count. The trees resprayed with Sevin were adequately disinfested and little difference was demonstrated between dosages ranging from 2 to 4 pounds of 50% Sevin per 100 gallons.

TABLE 1
European Earwig Control—Franquette Walnuts
1959—Santa Clara County

MATERIALS	DOSAGE PER 100 GALLONS	PER CENT REDUCTION OF EARWIGS*				
		MAY 8	MAY 16	MAY 22	MAY 29	JUNE 4
Thiodan	4 lbs. 25% wettable	84	85	54	43	..
Sevin	4 lbs. 50% wettable	99	99	98	94	91
Dieldrin	3 pints 1.5 lbs. per gal. E.C.	82	87	54	37	..
Check	0	4	35	39	39

* As compared with pretreatment counts.

The same orchard was used again in 1960. Plots were established to test wettable Sevin at varying dosages, 50% Sevin plus oil, and a 5% granular formulation of Sevin. The same evaluation technique as described above was used, and the results were as follows: Sevin wettable powder at 4 pounds per 100 gallons gave the best control, and lower dosages were not effective. The addition of oil did not improve the control, and the granular formulation was ineffective.

GRAPE MEALYBUG

The grape mealybug, *Pseudococcus maritimus* (Ehrh.), although a common pest of pome fruits, grapes, and ornamentals, is a relatively new pest of apricot. Essig (1958) lists a large number of both cultivated and native plants, including grapes, apples, pears, and walnuts, as hosts of the grape mealybug.

The mealybug seems to be limited to the coastal apricot growing districts even though it is commonly encountered on other hosts in the hot interior of San Joaquin Valley. Since the pest is of economic importance to apricots, studies on the biology and control were initiated in 1957 and continued through 1959. It

was first reported as a pest on apricots by Madsen and McNelly (1959).

Field Identification

Adult female mealybugs are about $\frac{1}{4}$ inch long, dark purple in color, and covered with a uniformly distributed, white, powdery wax. They are commonly found beneath bark scales, at the base of shoots, and other areas which provide a protective cover. Filaments of wax extend from the margin and the posterior end of the body. The wax filaments produced near the tail end may extend backwards by half a body length.

The immature mealybugs resemble the adults except for size in all but the first

For reader convenience, it is sometimes necessary to use trade names of products rather than complicated descriptive or chemical identifications. In so doing, it is sometimes unavoidable that similar products which are on the market under other trade names may not be cited. No endorsement of named products is intended, nor is criticism implied, of similar products which are not mentioned.

instar or crawler stage; mealybugs in this stage are flattened, yellow to brown in color, and free of the waxy coating characteristic of the later growth stages. The eggs are oval in shape, yellow to orange in color, and are found within cottony egg sacs deposited by the females.

Seasonal Life History

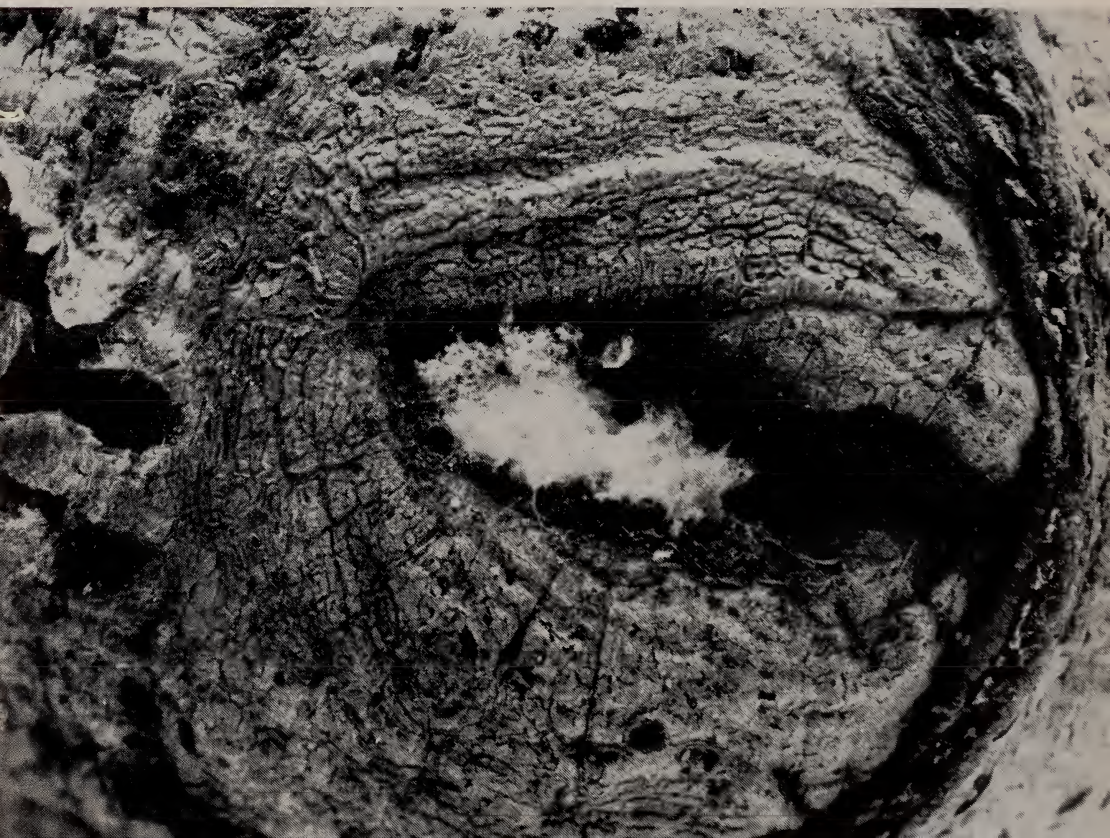
The life history of the grape mealybug on apricot is similar to that reported by Doult and Hagen (1950) on pear. The mealybugs overwinter as crawlers within the cottony egg masses deposited by the females. These egg masses are found under bark scales and in cracks and crevices on the trunk and main limbs (fig. 7). The crawlers become active in response to warm weather and the growth of the tree during spring. After the tree blooms in March, crawlers can be found clustered at the bases of new shoots. Throughout the early spring period they feed upon the tender new tissue at the base of these shoots and only rarely are found out on

the leaves. The mealybugs reach maturity during late May, and adult females then lay eggs in the cracks of the bark. The eggs hatch during June, and the crawlers of the first summer brood move to the base of shoots as well as to the leaves and fruit. They prefer to colonize areas that offer protection, and are commonly found at the stem ends of fruit or on the sides when the fruits are touching. The short stem of an apricot lies flat against the fruit close to the twig, and the stem end then offers a place for concealment. The first summer brood of mealybugs matures by August, after the fruit has been harvested. Adult females crawl to the trunks and main limbs where egg masses are deposited. The eggs hatch by September, and the crawlers remain in the old egg sacs until the following spring. There are two complete generations per year.

Injury

The principal damage caused by grape mealybug on apricots is the accumulation

Figure 7. Overwintering egg mass of grape mealybug on apricot.



of honeydew on the fruit (fig. 8). A black fungus which grows in the honeydew gives the fruit an unsightly appearance. In addition, the skin of the apricot turns red beneath and bordering the honeydew deposit. The mealybugs produce copious quantities of honeydew; colonies in the stem end of a fruit will cause a sticky and sooty deposit in this area and on the sides of the fruit. A fruit thus affected is downgraded in the fresh market and is considered to be a cull by processors of unpeeled halves.

Control

The studies on control of the grape mealybug were mainly concerned with proper timing of treatments. Other workers such as Stafford and Kido (1955), and Frick and Bry (1955) have indicated the effectiveness of organic phosphates, especially parathion, against this pest. Control experiments by Madsen and McNelly (1959) showed that fall and winter sprays containing phosphates in combination with oil were less effective than spring sprays timed for the emergence of crawlers. This was due to the protection afforded by the location of overwintering colonies and by the presence of waxy fibers which resisted wetting. Of the compounds tested, parathion and Diazinon gave the best control regardless of the timing. Additional experiments by Madsen and McNelly (1960) indicated that spring sprays at either the pink bud or petal fall stages were preferable to sprays timed to the appearance of the first summer brood in early June. As was the case in earlier trials, parathion or Diazinon provided the best control. There is some overlap between the overwintered brood and the first summer brood, and it is not always possible to spray before some individuals find protection in the stem end of the fruit. Sprays applied in advance of the emergence did not provide enough residual action to control those mealybugs which hatch two to three weeks after sprays are applied. Experiments com-

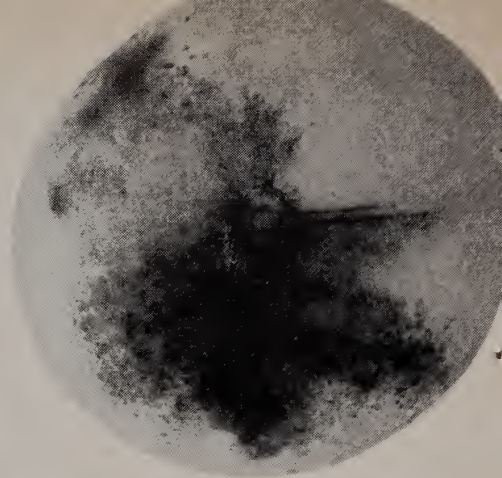


Figure 8. Honeydew secreted by grape mealybug on apricot fruit.

pleted during the period 1958–1959 have led to the suggestion that parathion or Diazinon be used at the petal fall stage of tree development. This timing gives good control of grape mealybug and provides added benefit on other apricot pests active at this period.

ORANGE TORTRIX

As indicated by its name, the orange tortrix, *Argyrotaenia citrana* (Fern.), is a pest of citrus. Basinger (1938) considered the orange tortrix to be the most injurious of the moths which attack orange and other citrus fruits. In northern California, the orange tortrix is a pest of both pome and stone fruits. It is widely distributed in the coastal fruit-growing areas but is only rarely encountered in the interior valleys. There has been some confusion as to the identity of the orange tortrix in northern California. Specimens collected from apricot have been identified as the apple skinworm, *Argyrotaenia franciscana* (Wlshm.). Studies by Bartges (1951) showed that the species in northern California is the same as orange tortrix collected from citrus in southern California. Until further studies clarify the role of the apple skinworm in deciduous fruits, the apricot pest should be considered as the orange tortrix.

Field Identification

The adult orange tortrix is a brownish to buff colored moth with a wingspread of 12 to 16 mm. As with most members of the family Tortricidae, the folded wings form the shape of a bell when the moth is at rest. There is a dark line or diagonal band across each forewing which forms a V when the wings are folded. There is considerable variation of size, wing color, and intensity of the diagonal band among individuals.

The larvae exhibit the tortricid characteristic of backward wriggling when disturbed and will often drop on a silken thread. The mature larva varies in color from light green to tan, with a brown head and prothoracic shield (fig. 9). The translucent or cream-colored eggs are laid in overlapping masses of 10 to 20 (fig. 10).

Seasonal Life History

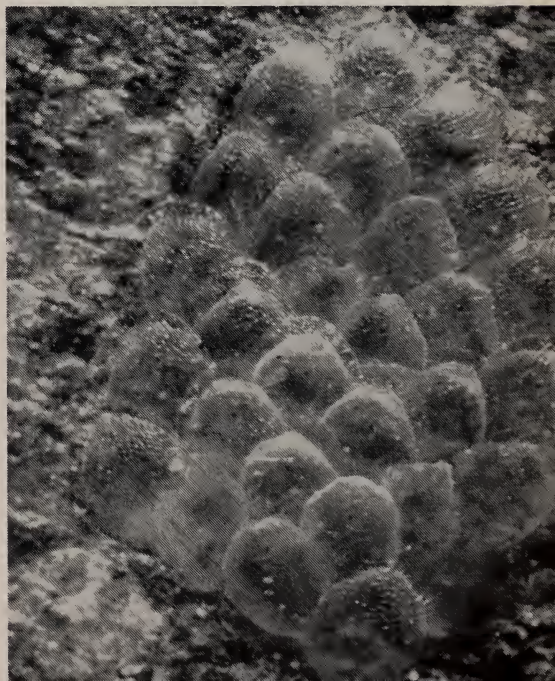
The life history of the orange tortrix on apricots is basically the same as reported by Lange (1936) and Basinger (1938) on citrus. The insect spends the winter in one or another of its several stages, but the larval stage is most often encountered. Larvae can be found within nests constructed of old leaves on the twigs, or actively feeding on mummified fruit left in the tree. The spring and summer generations can overlap considerably because populations of the orange tortrix overwinter in various development stages. The number of generations varies from two to four per season, depending upon seasonal weather conditions and availability of suitable food. Larvae are generally found in the foliage during the spring months, where they fasten leaves together with silken threads; they may also tie a leaf to a fruit, or may live between fruits that are touching. Seldom are larvae found on exposed leaf or fruit surfaces. Pupation takes place within the feeding sites and the moths mate within a short time after they emerge. The moths



Figure 9. Larvae of the orange tortrix.

are not attracted to bait pans or light traps used to determine the flight of codling moths, and therefore the peaks of moth emergence have not been determined in apricot orchards. Egg masses are deposited upon the smooth bark of the main limbs, or on foliage and fruit. On occasion, eggs are found beneath loose scales of bark on the tree trunk. Since there is an overlapping of broods all stages may be found at any one time.

Figure 10. Egg mass of the orange tortrix.



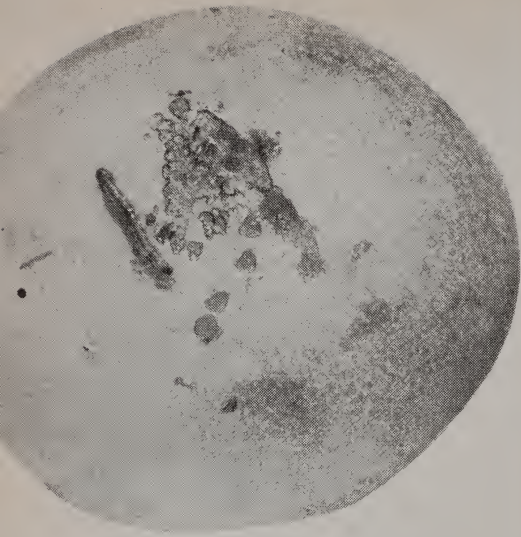


Figure 11. Orange tortrix larva and feeding area on side of apricot.

but the peak of larval activity seems to occur in late June or early July, shortly before the fruit matures.

Injury

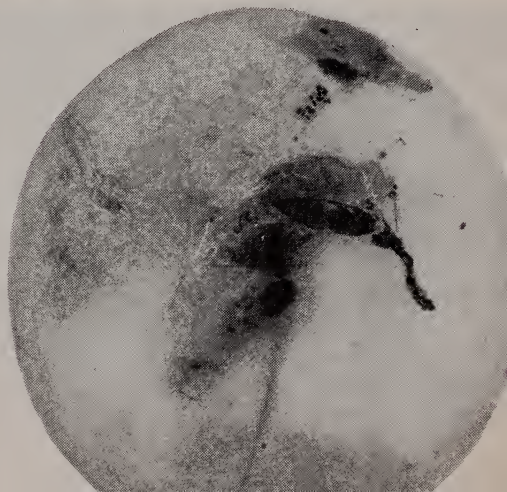
The orange tortrix is primarily a leaf feeder as are most of the tortricid pests of fruits. Larvae will feed on the fruit, however, and the economic importance of the pest is due to this habit. Since the larvae prefer to feed in protected places, they attack apricots at the stem end, where the twig affords shelter, or between fruits that are touching; they do not penetrate deeply into the apricots but feed upon the surface (fig. 11). An irregular, shallow feeding area or scar is the result. Since larva population is greatest shortly before harvest, apricots are often picked with a minimum of damage but with larvae present in the stem end. Larvae are often not removed during processing and a high insect fragment count may occur in the finished product. For this reason, processors demand a high degree of orange tortrix control before the fruit is accepted. A typical stem end injury on apricot with a pupa still present is illustrated in figure 12. The orange tortrix

larva produces webbing in its feeding site. The presence of web serves to distinguish the injury from holes produced by earwigs, diabrotica beetles, or other surface-feeding pests of apricot.

Control

Chemical control of the orange tortrix on apricot was first investigated by Madsen, Borden, and Clark (1953). It was found that the timing program established for codling moth control would control orange tortrix but that different spray chemicals were needed. Borden, Madsen, and Benedict (1949) had previously determined that the orange tortrix was not susceptible to DDT, the insecticide suggested for codling moth control. TDE, a closely related compound, proved to be effective against both species. An additional complication was added to the problem of chemical control on apricot: the fruit is subject to high residue deposits because of the pubescence on the surface. The fruit is picked ripe and will not tolerate the same amount of washing that removes residue on other green fruits. In addition, some apricots are used for drying, a process which increases the residue hazard. For these reasons it was necessary to adopt insecticides which leave a minimum of residue on the fruit. Phosphate insecticides were evaluated by Madsen and Borden (1954) and ade-

Figure 12. Damage to apricot by orange tortrix with pupa at the feeding site.



quate control was obtained with the use of parathion or malathion. In order to more accurately define the proper timing of treatments additional studies were conducted. It was found that a petal fall spray in April, followed by a second application in mid-May, gave protection from orange tortrix attack. A spray applied in June rather than in mid-May also provided excellent control. Since the May timing is essential for codling moth control this is the logical time to treat for orange tortrix also, because both pests are thus attacked.

Parasites undoubtedly play a role in reducing orange tortrix populations, which fluctuate from heavy to very light. There is no regular pattern of year-to-year fluctuation, and not enough is known about the effect of parasites on orange tortrix populations to be able to predict in advance whether or not artificial controls will be necessary.

FRUIT TREE LEAF ROLLER

One of the oldest pests of deciduous fruit trees in California is the fruit tree leaf roller, *Archips argyrospila* (Walker). According to Newcomer (1950), it is a more common pest of apples and pears, although it has also been reported from citrus, walnuts, and stone fruits, especially apricots. Hawley (1927) reported it to be an important pest of apricot in Utah, and Smith (1952) listed it as a major pest of apricots in California.

Field Identification

The fruit tree leaf roller is another member of the family Tortricidae, and the adults show the typical bell shape of the wings when at rest. The moth is approximately $\frac{1}{2}$ inch long and has rusty-brown colored wings marked with areas of white and gold. The larvae are typical leaf rollers and will wriggle backward when disturbed. They have a dark green body with a black head and prothoracic shield. The color varies from light to dark green depending upon stage. The

later instars are darkest in color. Eggs of this species are very distinctive. They are laid in masses and are covered with a gray secretion (fig. 13).

Seasonal Life History

Overwintering takes place in the egg stage, and hatching begins early in the spring. The larvae are often found in late March, prior to the bloom stage of the tree. Young larvae feed on leaves as soon as the buds open, and they may tie several leaves together or fold over the edge of a single leaf. Larvae reach maturity in May, and pupate within the larval nest. Moths emerge from May to early June and deposit the overwintering eggs. There is a single generation per season.

Figure 13. Overwintering egg masses of the fruit tree leaf roller.



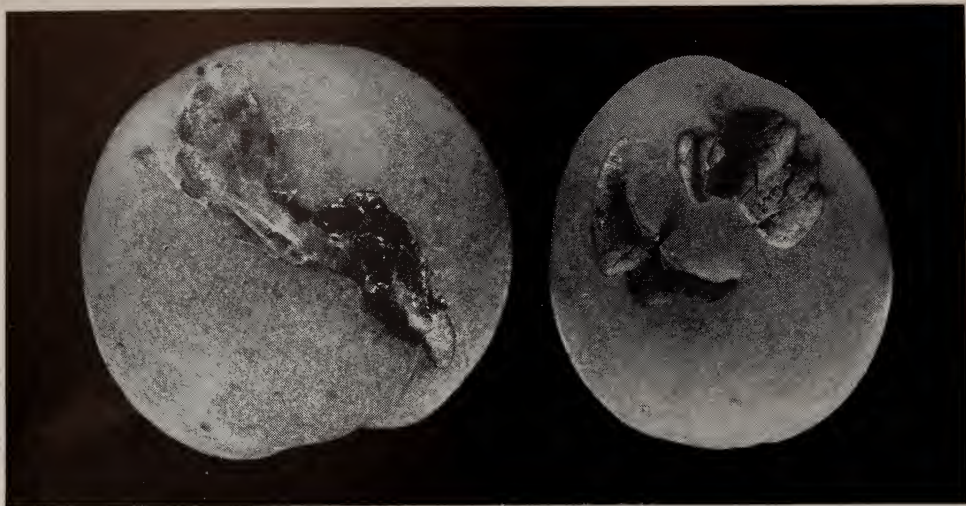


Figure 14. Apricots damaged by larvae of the fruit tree leaf roller.

Injury

The fruit tree leaf roller, as the name implies, is principally a leaf feeder. Considerable foliage damage can occur when leaf rollers occur in large numbers. The more important aspect of their attack, however, is injury to the young fruit. Larvae will feed on the fruit, often penetrating to the pit. Deep scars which form will heal over by harvest (fig. 14). In many instances, the larvae tie a leaf to a fruit and feed from under this protective cover (fig. 15). Fruits so injured are classed as culls and cannot be used. Since the leaf roller is an early season pest, its presence may go unnoticed until damage has occurred.

Control

Control of the leaf roller can be obtained if the orchardist applies sprays for other pests, such as peach twig borer or orange tortrix, at either the pink bud or petal fall stages. In most commercial apricot orchards a spray is applied at one of the above times and the fruit tree leaf roller is seldom bothersome.

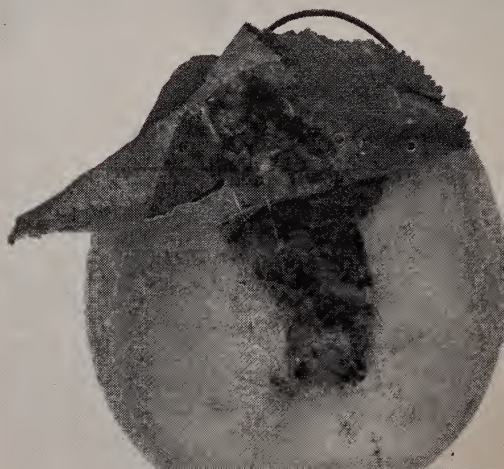
Leaf roller infestations are not readily detected during the winter, as most of the egg masses are deposited in the upper

third of the tree. The presence of webbed leaves shortly after bloom is a sure sign that leaf roller is present, and sprays applied at the petal fall stage will prevent damage.

MISCELLANEOUS CATERPILLARS

The three moth pests described below are classed as general feeders that occasionally attack apricot, but they are not considered as major problems and a spray program applied for other insects will usually control these caterpillars.

Figure 15. Leaf tied to fruit by fruit tree leaf roller.



GREEN FRUIT WORMS

Members of the genus *Orthosia* are generally referred to as green fruit worms; and one in particular, *Orthosia hibisci* (Guenée) has been implicated in damage to apricots.

Field Identification

The full grown larvae are the stage generally encountered in the field. They are 30–40 mm. long, light green in color, with a cream-colored dorsal line extending the length of the body (fig. 16). There are two less distinct lateral lines and two subdorsal lines as well. The adult is a typical member of the family Noctuidae and is difficult to distinguish from other cutworms.

Seasonal Life History

According to Raski and Borden (1949), the larvae were collected from apricot in late March, at which time they were partially grown. After the larvae reached maturity in April, they dropped to the soil to pupate. Moths did not emerge until the following year, which indicates a single generation per season.

Injury

In most cases the larvae feed on leaves and tie them together with silk. This damage is not economically important unless dense populations are present. The larvae will occasionally feed on fruit and take numerous small bites from a single apricot. Since the damage is done early, the feeding areas heal by harvest time, but the resulting scars cause the fruit to be classed as culls.

Control

Green fruit worms are normally controlled by spray practices directed against other pests. Since they appear early in the season it is possible to overlook an infestation until damage occurs. The insect is probably held under control by natural factors, since in most seasons



Figure 16. Green fruit worm larva.

the green fruit worms are encountered only in small numbers.

WESTERN TUSSOCK MOTH

Another pest with a wide host range and which can attack apricot is the western tussock moth, *Hemerocampa vetusta* (Bdvl.). The insect is only rarely encountered in commercial apricot orchards but can be a pest of backyard trees.

Field Identification

The larvae of the western tussock moth are very distinctive and thus would not be easily confused with other caterpillars. They are 13–25 mm. long, gray in color, and with numerous red, blue, and yellow spots. The presence of four dorsal and one posterior white tufts along with two long anterior and one posterior black tufts serves to identify the caterpillar (fig. 17).

Seasonal Life History

Overwintering eggs are deposited in masses on the bark of the limbs and trunk. The eggs hatch early in the season, during the bloom of apricots, and the larvae complete development by May. Pupation takes place in silken cocoons located in protected places on the tree. The females are wingless and, after mat-



Figure 17. Larva of the western tussock moth.

ing, often lay eggs upon the old cocoons. There is a single generation per year.

Injury

The western tussock moth is primarily a leaf feeder but may also feed on young fruit. Madsen and Borden (1953) describe the damage on fruit as shallow holes which heal over by harvest time and appear as shallow, scabby, depressed areas (fig. 18).

Control

It is usually not necessary to apply treatments for the control of western tussock moth because natural factors hold the insect below economic levels in most seasons. In addition, sprays applied in commercial orchards for other pests will control the insect.

CANKERWORMS

Cankerworms, or loopers, were at one time important pests of stone fruits according to Vosler (1915), but the advent of the modern insecticides have reduced them to minor status. Two species may be found on apricot, the fall cankerworm *Alsophila pometaria* (Harris) and the spring cankerworm *Paleacrita vernata* (Peck).

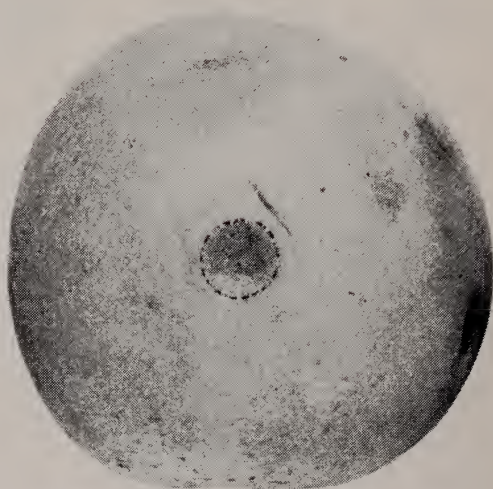
Field Identification

The larvae of both species are typical "measuring worms" of the family Geometridae. They are similar in appearance and color. When mature, the larvae are approximately 1 inch long, green in color, with stripes of lighter green along the sides below the spiracles. The two species can be separated by the presence of a third pair of prolegs on the fifth abdominal segment of the fall cankerworm. The spring cankerworm lacks prolegs on the fifth segment.

Seasonal Life History

The two species are present on the tree at the same time, even though their life histories are different. The spring cankerworm overwinters as a pupa in the soil, and the adult emerges in early spring. Its eggs are laid on the twigs and limbs; after hatching, the larvae feed on the foliage and fruit. When mature they drop to the ground and enter the soil to pupate. The fall cankerworm overwinters in the egg stage. The eggs of this species hatch about the same time as those of the spring cankerworm. Larvae drop to the

Figure 18. Tussock moth damage to fruit.



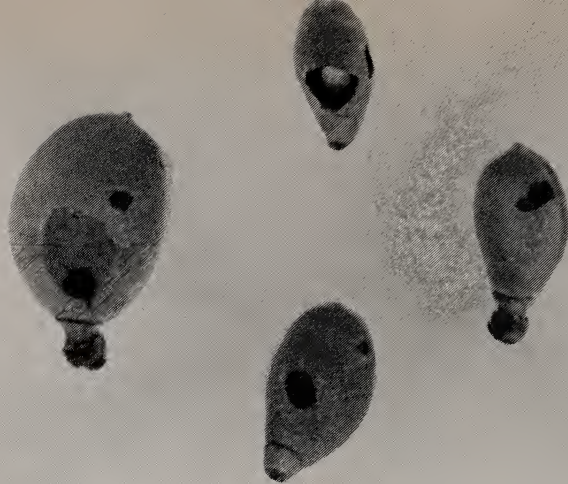


Figure 19. Cankerworm damage to young apricots.

ground when mature, enter the soil, and pupate. The moths emerge in the fall, mate, and lay overwintering eggs.

Injury

Cankerworms are primarily leaf feeders but often attack the fruit. They cause deep feeding holes which heal by harvest time (fig. 19). Injured apricots have deep, roughened scars which cause the apricots to be rejected for fresh or processed fruit.

Control

Insecticides used for other early season insect pests will effectively control the cankerworms. The timing of treatments at the pink bud or petal fall stages provides toxic residues when larvae are present. In most cases cankerworms are encountered as pests only in backyard or semi-abandoned orchards.

THRIPS

There are a number of species of thrips that have been associated with apricots, but none are considered as major pests. Two members of the genus *Franklinella*, *F. minuta* Moulton and *F. occidentalis* (Perg.), have been noted on apricot according to Bailey (1938). The above species are called flower thrips and are

responsible for damage to a number of deciduous fruits. Other thrips, which are predacious, may be found on apricot fruits and on occasion may present a problem to the canner because their remains contaminate the processed fruit. Bailey (1960) listed the following species as recorded from apricot: *Aeolthrips jasiatus* (L.), *Aeolthrips kuwani* (Moulton) and *Leptothrips mali* (Fitch). Since the flower thrips are the only ones of economic importance, they alone will be discussed in more detail.

Field Identification

The two species of *Franklinella* mentioned above are difficult to distinguish in the field. *F. occidentalis* is the larger of the two species and is lemon yellow to dusky yellow brown in color. The smaller of the two, *F. minuta*, is uniformly dark brown.

Seasonal Life History

Flower thrips have several generations each year. Reproduction is continuous in areas where winter temperatures remain above freezing. Where temperatures drop below freezing, the thrips hibernate in the adult stage. There is a large number of different plant hosts for the flower thrips and the adults and nymphs feed

upon flowers, foliage, and fruit. Eggs are inserted into the plant tissue, and when the larvae complete development they drop to the ground to pupate. Populations of flower thrips build up rapidly in spring. Invasion of fruit orchards usually coincides with field crop harvesting or disking of cover crops, and springtime drying of grasslands or foothill vegetation.

Injury

In central and northern California, apricots usually are past the bloom stage before flower thrips build up in sufficient numbers to cause damage. In southern

California, the thrips may invade the orchards earlier, and cause fruit russet or scarring especially on the Tilton variety. The tender new foliage is often attacked but damage to leaves is trivial.

Control

It is seldom necessary to apply insecticides for thrips control. If apricots are grown in an area where fruit scarring is a problem, a residual insecticide applied just prior to bloom will give control. Treatment during bloom should be avoided because of the potential danger to pollinating insects, especially honeybees.

FRUIT FEEDERS

PEACH TWIG BORER

The peach twig borer, *Anarsia lineatella* (Zell.), is a widely distributed pest of stone fruits throughout the United States and is also found in Europe and Asia. It is a primary pest of peach and almond but also attacks apricot as well as plum and prune. The peach twig borer is prevalent in the San Joaquin and Sacramento valleys. It is less frequently encountered in the coastal districts where the majority of the apricot acreage is located.

Field Identification

The newly hatched larva, as described

Figure 20. Peach twig borer hibernaculum on apricot twig.



by Bailey (1948), is light yellowish brown with a black head. The mature larva is brown to chocolate with light colored bands encircling each abdominal segment. The presence of these light intersegmental membranes as contrasted with the brown body serves to distinguish peach twig borer larvae from other moth larvae associated with apricot. The adult moth is dark gray in color with spots and streaks of lighter gray. The wings are held roof-like over the body. Adults are not usually noticed in orchards, as they rest upon the bark during the day and their protective coloration makes them difficult to see.

One of the indications of peach twig borer attack in spring is the presence of wilted shoots on the terminal growth. Larvae of the May brood burrow into the growing shoots, causing them to wilt and die.

Seasonal Life History

A number of workers have contributed to the life history studies of peach twig borer in California, among them Clarke (1902), Duruz (1923), and Jones (1935). The peach twig borer overwinters as a first instar larva within a hibernaculum constructed in the bark

(fig. 20). The overwintering site is marked by a chimney of frass and is most frequently located in the crotch of a limb or twig. The larvae emerge in early spring, usually during the bloom stage of the tree and attack opening buds and growing shoots. After reaching maturity, the larvae migrate to the larger limbs and trunk and pupate in cracks, pruning scars, or beneath loose bark. Adults of the first generation emerge in May and, after mating, deposit eggs on the bark, leaves, or fruit. The larvae of the May brood attack the growing shoots, producing a characteristic wilting which serves as field evidence of twig borer attack. Fruit may also be invaded during this period. According to Summers (1955) the second generation appears in peak numbers during July when most of the apricots have been harvested. The larvae of this generation then feed upon twigs or bark, but may cease feeding and enter the bark where they remain until the following season. Since there is little reproduction in apricot orchards after mid-July, heavy populations of twig borers rarely develop. On other hosts, the twig borer can complete a third and a partial fourth generation.

Figure 21. Peach twig borer and damage to apricot.

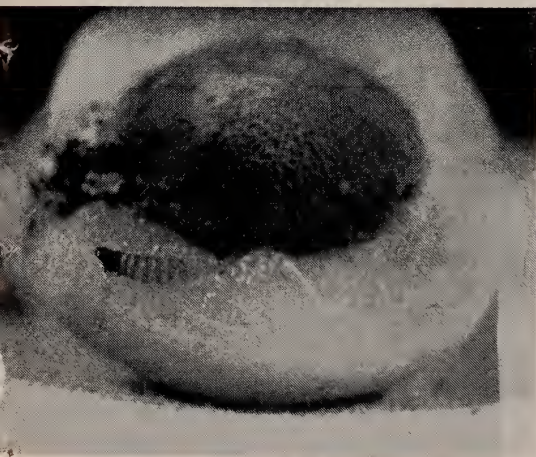


Figure 22. Peach twig borer larva showing typical frass left at feeding site on apricot.

Injury

Although the larvae of peach twig borer attack developing buds and shoots, this damage is not economically important to apricot growers. The larvae are usually unable to enter green fruits and damage to the fruit occurs when the apricots begin to ripen. They feed near the stem end or along the seam but rarely penetrate to the pit (fig. 21). One larva may make several entrance holes which are marked with scattered areas of frass (fig. 22). Fruit thus affected is unsuitable for market or processing.

Control

Madsen and Borden (1953) state that the peach twig borer on apricots can be controlled with a spray applied either at the pink bud or petal fall stages of tree development. Timing of the spray depends upon the area and the other pests involved. In the interior valleys, where the peach twig borer is often the only major pest, sprays can be combined with fungicides at the pink bud stage. In the

coastal areas, where other lepidopterous pests must be considered, it is best to treat for twig borer at the petal fall stage.

CODLING MOTH

There is little doubt that the orchard entomologist has been more concerned with the codling moth, *Carpocapsa pomonella* (L.), both historically and at present than any other insect. It is primarily a pest of apple and pear but in California will also attack stone fruits and walnuts. According to Essig (1931), Matthew Cooke, in 1883, was the first entomologist to describe the codling moth on peach and apricot in California. It has also been reported at attacking apricots in South Africa by Pettey (1925) and in France by Bovey (1949).

Field Identification

The adult is approximately $\frac{1}{2}$ inch long with a wing expanse of $\frac{1}{2}$ to $\frac{3}{4}$ inch. When at rest, the wings are folded back over the body (fig. 23). The forewings are mottled gray and brown. This coloration blends into the background of the tree bark. The most distinguishing characteristic is the presence of a coppery

Figure 23. Adult codling moth.



spot on the inner margin of the tip of each forewing. The egg is flattened, oval in shape, and is clear when first deposited. As the larva develops the egg first shows a red ring, and before hatching the young larva is clearly visible.

A newly hatched larva is white in color with a black head and thoracic shield. The full grown larva is usually pink in color with a mottled brown head. The pink color is not present in the overwintering larvae. Mature larvae are $\frac{1}{2}$ to $\frac{3}{4}$ inch long. Pupation takes place in a flat, silken cocoon which is usually spun under loose bark scales. When the adult emerges the empty pupal case is characteristically left projecting from the bark.

Seasonal Life History

The number of generations per season depends upon the host. Michelbacher and Ortega (1958) state there are two complete broods on walnut. On pears there may be a third brood according to Madson and Barnes (1959). According to bait pan records for apricot orchards, there seems to be a single brood in California. Smith (1929) indicated that a single brood occurs on apricots and other stone fruit orchards. Pettey (1925) in South Africa also stated that a single brood appeared to have developed in apricots, but the bait pan records of Bovey (1949) show two complete broods in France.

Examination of apricot orchards during the winter and spring has shown that the codling moth overwinters behind the bark scales on trees. This indicates that a resident population is present and that apricots are not infested by flights from other hosts. Additionally, many infested apricot orchards are located several miles distant from the nearest pear, walnut, or apple orchards.

Emergence of the first brood is dependent upon winter and spring temperatures. The first moths may appear in late April or in May. Bait pan records in apricots throughout several seasons

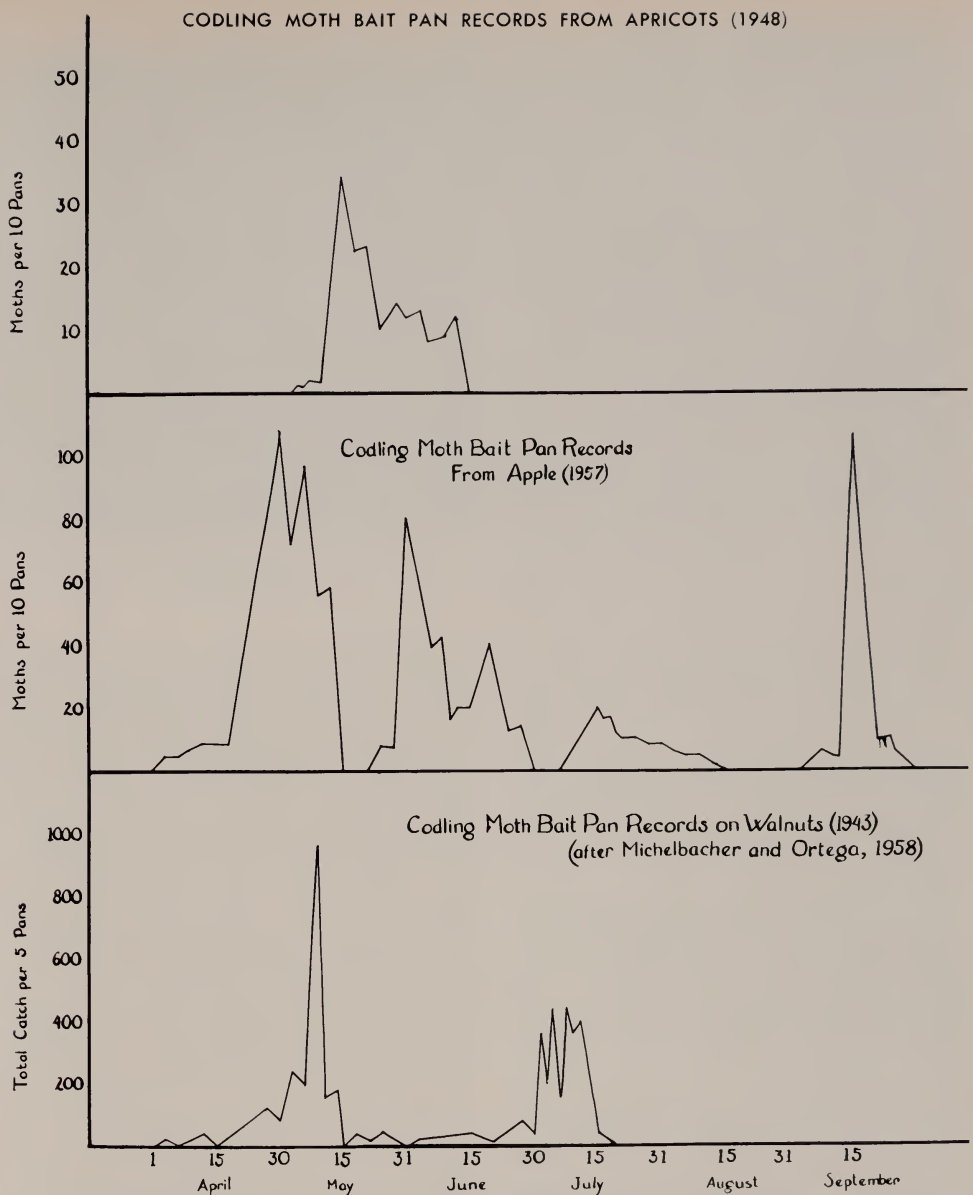


Chart 1. Bait pan records of codling moth flights from apricots, apples and walnuts.

showed the first emergence to be in early May. The flights reached a peak in mid-May, and a few moths were trapped in early June. Chart 1 shows a comparison of bait pan records for apricot, apple, and walnut orchards. It is evident that the first brood emerged at about the same time on all three hosts and that a second brood flight did not occur in the case of apricots.

It is probable that a strain adapted to the host has developed. Apricots are usually picked early in July, so that there would be no food available for a second brood if one did emerge. Infestations are usually not severe in apricots, although local outbreaks can occur. Borden and Madsen (1949) reported that in certain orchards of Santa Clara County losses ranged from 30 to 50 per cent during

the 1948 season. Infestations have fluctuated since that time, but no reports have been received of infestations approaching the intensity of those reported above. It is doubtful that the codling moth could be a serious pest each year with but a single generation. It has been stated that apricots are not a preferred host, but the more likely explanation is that the codling moth becomes a serious pest on apricots only under conditions which favor an extremely heavy first brood.

Injury

The codling moth attacks the fruit directly, leaving an entrance hole plugged with frass as a characteristic sign of infestation (fig. 24). The larvae bore directly to the pit and feed on the flesh of the apricot in this area (fig. 25).

Fungi are introduced by the feeding of the larvae, and the inside of the apricot becomes discolored and partially rotted (fig. 26). An infested apricot is of no value for fresh market, processing, or drying.

Control

The codling moth can be controlled with a number of insecticides if applications are properly timed. Borden and Madsen (1949) showed that the compounds used on pome fruits also control



Figure 25. Apricot attacked by codling moth larva.

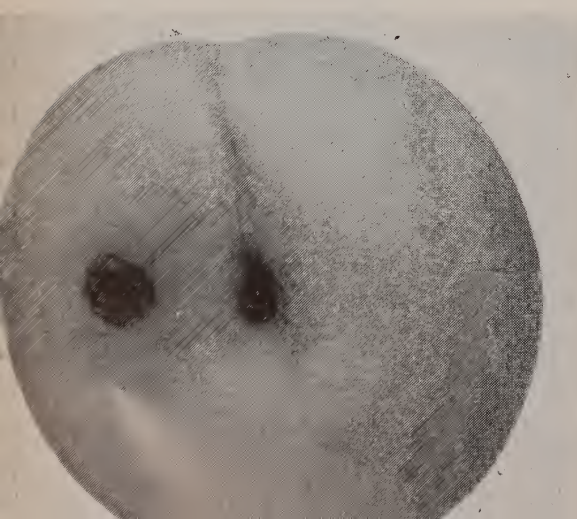
codling moth on apricots. Tests by Madsen and Borden (1954) indicated that because of the residue problem on apricots phosphate compounds such as malathion and parathion were satisfactory. Methoxychlor, which has a lower mammalian toxicity, was also effective. Residue studies by Borden, Madsen, and Benedict (1950) showed that residues were uniformly low with phosphate compounds, but relatively high with chlorinated hydrocarbons such as TDE and DDT. Residues of these latter materials were also high on dried fruit, whereas those of parthion were still very low.

Since the first brood activity of codling moth on apricots is fairly short in duration, residual compounds are not as essential as for apples and pears. If sprays are properly timed to the moth flight, good control can be obtained. Bait pans are useful for determining the proper time to apply sprays. The standard bait described by Borden (1932) consists of diamalt, water, and yeast.

WESTERN SPOTTED CUCUMBER BEETLE

The western spotted cucumber beetle, *Diabrotica undecimpunctata* Mann., is a pest of a great number of agricultural

Figure 24. Entrance hole of codling moth in apricot.



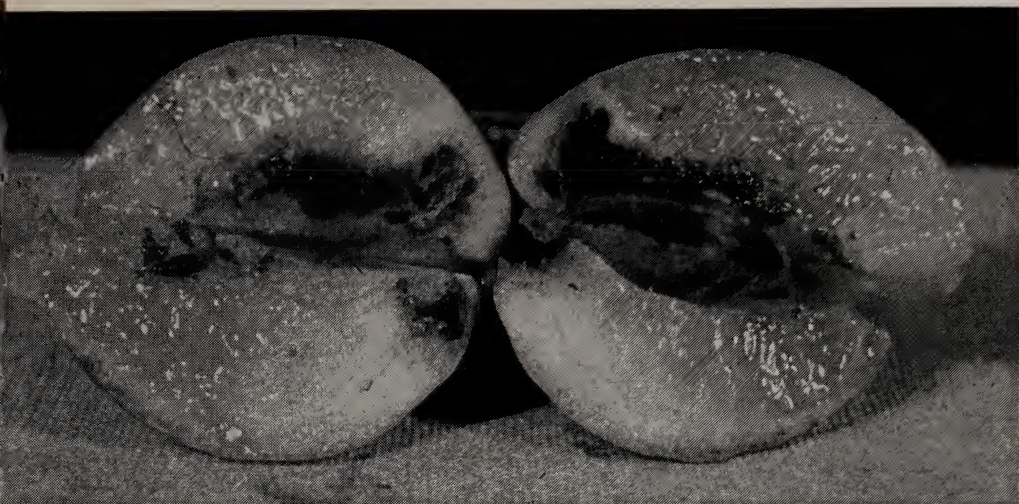


Figure 26. Apricot showing typical damage caused by codling moth.

crops in California. Although mainly a pest of vegetable and field crops the beetle can, under certain conditions, seriously attack deciduous fruits. Apricots in both the interior valleys and coastal districts may suffer damage, and most of the injury occurs on ripening fruits.

Field Identification

The adult beetle, which is the stage encountered in apricot orchards, is about $\frac{1}{4}$ inch long. The wing covers are green in color with eleven black spots. The head, prothoracic shield and posterior end are black.

Seasonal Life History

According to Michelbacher, Middlekauff, Bacon, and Swift (1955), the insect spends the larval and pupal stages in the soil. Eggs are laid on or near the bases of herbaceous host plants. The larvae feed upon the roots and construct cells in the soil in which to pupate; when the adults emerge they fly to various host plants to feed. In the San Joaquin Valley, there are three overlapping generations per year. The insect passes the winter in the adult stage. Beetles fly into apricot orchards early in the summer and their

flights are often associated with the drying of adjoining weedy or grassy areas.

Injury

Michelbacher, MacLeod and Smith (1943) describe two types of feeding injury on apricot fruits. Primary damage consists of feeding holes ranging from small, superficial holes to large, deep cavities (fig. 27). Secondary damage results when the beetles feed upon fruit that has already been injured by some other agent. In either case, the fruit is subject to brown rot and the loss caused by the disease may be more important than the damage from the feeding itself. The feeding injury resembles that caused by earwigs and the two types of damage may be confused. In most cases the severity of damage is greatest to fruit that is ripe or nearly so.

The beetles also feed upon leaves, but this is of no economic concern.

Control

The prevalence of beetles in an orchard depends upon a number of factors. Michelbacher, MacLeod and Smith (1943) state that the size of the first brood depends upon rainfall. A good



Figure 27. *Diabrotica* damage to apricots.

growth of vegetation in uncultivated areas after adequate rainfall provides ideal conditions for population increase. The date on which the vegetation dries up also determines when the adults may migrate to orchards. Serious infestations are likely to occur only during seasons in which conditions are favorable for beetle development in uncultivated areas.

Since the beetles attack maturing fruit,

crops may be contaminated if residual insecticides are applied. Pyrethrum dusts have given control in past seasons when it has been necessary to treat. In some cases, strip treatments to protect the borders have given satisfactory results. Dust formulations of organic phosphate have given control in other crops but they have not been tested on apricots for this pest.

TWIG AND LIMB FEEDERS

EUROPEAN FRUIT LECANIUM

The European fruit lecanium, *Lecanium corni* Bouché, also known as the brown apricot scale, is a widely distributed pest of deciduous fruits and nuts in the western states. It is one of the common scale pests of apricots wherever the crop is grown in California, and is often associated with infestations of black scale.

Field Identification

Essig (1958) describes the shape of the adult scale as hemispherical, smooth,

of a shiny, brown color, and ranging from 3 to 5 mm. in diameter. The scale is often variable in both shape and color, depending upon the nature of the twig or branch infested (fig. 28). The eggs, which are laid beneath the female scale, are oval in shape and tan to pink in color. The crawlers are oval, flattened, and vary in color from yellow to brown.

Seasonal Life History

The insect spends the winter as an immature scale on the twigs and branches of the tree (fig. 29). According to Skelsey (1959) the overwintered scales represent the second instar in the development

of the insect. In spring, usually in March, the immature scales begin to grow, reaching maturity by April or early May. The eggs begin to hatch in late May and early June. The first instars or crawlers move to the leaves where they settle on both leaf surfaces. Individuals that survive the summer move back to the twigs prior to leaf fall in October and November. There is a single generation per year.

Figure 28. Adult European fruit lecanium.



Figure 29. Overwintering stage of European fruit lecanium.

Injury

Although feeding of the scale insects can cause some loss in tree vigor, the production of honeydew causes immediate damage. The scales maturing in spring produce large amounts of honeydew which drip to the foliage and fruit. The crawlers on the leaves produce a fine spray of honeydew which also settles on fruit, twigs, and leaves. A black fungus which grows in the honeydew causes such an unsightly appearance on the fruit that it is unmarketable. Entire trees will be darkened with sticky foliage when infestations are heavy.

Control

Parasites often hold the European fruit lecanium below economic levels. In the case of a similar species, the frosted scale *Lecanium pruinosum* (Coq.) on walnut, Michelbacher and Ortega (1958) state that it is seldom necessary to apply control measures if the natural enemies are not interfered with. If it is necessary to apply control measures, dormant sprays directed against the overwintering scales should give control. Jones and

Mowry (1943) found dormant oils to be very effective against this pest on stone fruits in Oregon. Sprays for controlling this scale should be applied in spring, prior to February 15 and before the scale begins to grow, otherwise the insect becomes very resistant to chemical treatment.

BLACK SCALE

The black scale, *Saissetia oleae* (Bernard), is a widespread pest of a number of important crops in California as well as ornamental trees and shrubs. Ebeling (1959) lists it as one of the major citrus pests, and it is commonly encountered in northern California on stone fruits and olives. On apricot, it is usually found associated with the European fruit lecanium and is present in both the coastal and interior valley apricot districts.

Field Identification

The full grown female scale is 3 to 5 mm. in diameter, usually black in color, and hemispherical in shape. The distinguishing character is the presence of two transverse and one longitudinal ridges which form the letter H on the dorsum. Males are usually scarce even when populations are high. The eggs, which are laid under the female scale, are round and pearly white in color. The crawlers are similar to the crawlers of the European fruit lecanium. They are oval in shape and light brown in color. The characteristic ridges begin to form on the dorsal surface during the second instar (fig. 30).

Seasonal Life History

In most areas, including the apricot-growing districts, the scale has one generation per year although it has two generations in certain regions close to the southern California coast. According to Quayle (1911), the scale passes the winter as a partly-grown insect which has completed two moults and is mature, but of small size. In the spring, as the trees



Figure 30. Immature black scale on twig.

begin to grow, the scales increase in size until maturity is reached in April and May. Eggs are deposited beneath the female scale and crawlers emerge in June and July. These move to the foliage and grow slowly during the summer months. In fall, prior to leaf drop, the scales move back to the twigs and branches where they settle in a permanent location.

Although there is a single brood, some overlapping of stages occurs during the periods of maturity, egg laying, and hatching.

Injury

In common with other scale insects, the black scale can cause a loss of tree vigor by withdrawing sap during feeding. The more direct injury, however, is due to the production of honeydew. The sooty mold fungus which grows in the honeydew can blacken both fruit and foliage. The fruit so affected may lose its market value. Heavy deposits on the leaves may reduce photosynthesis.

Control

As in the case of the European fruit lecanium, chemical control against this scale is best restricted to dormant treatment with oil. Although it overwinters in a more advanced growth stage than the European fruit lecanium it is usually susceptible to winter treatment. When the scale begins to grow in spring, it soon reaches what is called the "rubber stage." This term refers to the stage in which the scales are resistant to most insecticides. In most cases, it is not feasible to apply summer treatments because the crawlers make their appearance too close to harvest time. A number of parasites attack the black scale and these parasites may hold the insect in check unless they themselves are destroyed by chemical treatments.

MISCELLANEOUS SCALE INSECTS

A number of other scale insects are occasionally encountered on apricot, but none are important enough to warrant a description here.

Of the unarmored scales, Essig (1958) lists the soft scale, *Coccus hesperidum* L., frosted scale, *Lecanium pruinosum* Ckll., and the calico scale, *Lecanium cerasorum* Ckll.

There are also a few armored scales that occur on apricot. In the San Joaquin Valley, the parlatoria scale, *Parlatoria oleae* (Colvée) may cause considerable damage, but only a small percentage of the apricot acreage is grown in this area. San Jose scale, *Aspidiotus perniciosus* Comst., may occur in the coastal and interior valleys, and the oyster shell scale, *Lepidosaphes ulmi* (L.) is usually encountered only in abandoned or semi-abandoned orchards. In the Hemet Valley of southern California, two armored scales are frequently found in heavy populations on apricot. They are the Howard's scale, *Hemiberlesia howardi* (Cock-

erell), and Putnam's scale, *Diaspidiotus ancylus* (Putnam). These may be controlled by the application of oil during the fully dormant period.

SHOT-HOLE BORER

The shot-hole borer *Scolytus regulosus* (Ratz) is of European origin and is a general pest of deciduous fruits throughout the state of California. It is more often encountered as a pest of stone fruits than of pome fruits, and is generally associated with orchards that are neglected or of low vigor.

Field Identification

In the field, injury to the larger limbs or trunk is the primary method of identifying the presence of the beetle. Round holes in the branches and gumming of the buds often indicate beetle attack.

The larva or grub is legless and slightly curved and has a white body and a brown head. When full grown, the larva is about $\frac{1}{10}$ inch long. The anterior portion of the body is somewhat enlarged and the head is withdrawn into this area. The beetle is cylindrical in shape and nearly $\frac{1}{10}$ of an inch in length. The body and head of the beetle are dark brown to black. The antennae, legs and tips of the wing covers are cinnamon red or light brown. The body, head and wing covers are rugose and covered with short hairs.

Seasonal Life History

According to Smith (1932) the shot-hole borer overwinters beneath the bark as a larva with pupation occurring in the early spring. Adults of the first generation emerge between late March and mid-May.

The breeding period extends from late March through late October, and considerable overlapping of broods occurs after July. The spring generation requires two months to complete its cycle; therefore, it is possible that three complete generations and a partial fourth can be completed per season.

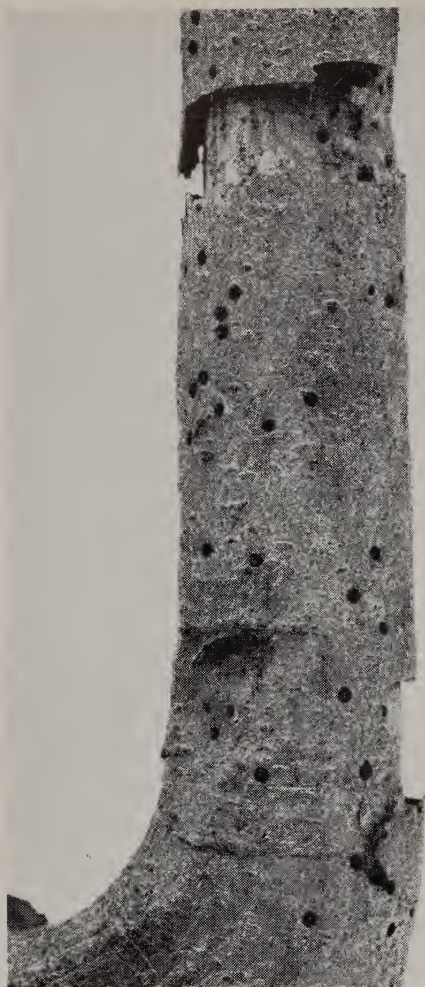


Figure 31. Branch with shot-hole borer damage.

In order to lay her eggs the female first constructs a short egg tunnel, usually in a main limb. The eggs are laid along the sides of the tunnel and are imbedded in wood strips. After oviposition the female backs out of the tunnel and closes the aperture with her body. The eggs hatch within a few days and begin to form feeding tunnels at right angles to the egg tunnel.

Injury

Feeding of both the adults and larvae is involved in damage to the tree. The beetles bore into the new wood at the base

of the buds, and both adults and larvae can damage the limbs and major scaffolds of the tree. The adults attack weak or injured limbs and, in many cases, can successfully enter and start a colony. They will also attempt to enter healthy wood at the bases of buds, but are unable to do so because the tree responds by profuse gumming. Repeated attack at this site, however, may eventually weaken the tree so that an entry can be made.

Limb injury is due to the tunneling of both adults and larvae through the inner bark and cambium layer (fig. 31). Beetles generally tunnel up or down a limb and seldom girdle it. Larvae, on the other hand, travel at right angles to the tunnels made by the adult, and their feeding may girdle a limb. The shot-hole borer is also responsible for mechanically transmitting several wood-rotting fungi.

Control

Trees suffering so slightly from lack of water that no visible effects are discernable may be weakened to the point of being attractive to the beetle. It is on such trees that the beetles inflict considerable damage to the bases of the buds on one-year-old wood.

Cultural practices which help to keep the trees in a high state of vigor are perhaps the best method of control. The beetle is incapable of establishing colonies in a healthy vigorous tree. Orchard sanitation is also important in controlling this beetle. Dead and dying wood removed from the tree in the fall contains the overwintering larvae; these will emerge the following spring. Therefore, the more the bark is stripped from the limbs or twigs with brush cutters the greater assurance of killing the overwintering larvae. It is also advisable to disk under the brush rather than leave it on the orchard floor. Larger limbs that are useful for stove or fireplace wood should be burned before February; if this is not possible, the wood should be treated with stove distillate to destroy the overwintering larvae. In no

case should infested wood be piled near an orchard, as it will provide a source of beetles which will attack trees the following spring.

MISCELLANEOUS WOOD BORERS

There are a number of wood-boring beetles that may on occasion attack apricot. They are all general feeders and do not restrict their attack to this host alone. Essig (1958) lists the following beetles which have been recorded on apricot: *Amphicerus cornutus* (Pallas), the western twig borer; *Prionus californicus* Mots., the California prionus; *Anisandrus dispar* (Fabr.), the pear blight beetle; *Chrysobothris mali* Horn, the Pacific flatheaded borer; and *Polycaon confertus* Lec., the branch and twig borer. The last two species are the only ones which are encountered with enough frequency to warrant further discussion.

PACIFIC FLATHEADED BORER

The Pacific flatheaded borer, *Chrysobothris mali* Horn, is a native species which attacks a wide variety of native trees and shrubs as well as deciduous fruits. On apricot it is principally a pest in new plantings.

Field Identification

The adults are typical buprestid beetles, about $\frac{1}{2}$ inch long. The color is bronze to copper with coppery spots on the wing covers. A mature larva is white in color, with a flat, broad area behind the amber colored head. The body behind the flattened region tapers towards the posterior end.

Seasonal Life History

Burke (1929) has described the life history in some detail, and little work has been done on the biology of this pest since. The beetle passes the winter in a

prepupal stage within the bark of the tree. Pupation takes place in the spring, and adults emerge in April through July. The eggs are laid in cracks and crevices of the bark; upon hatching, the larva bores directly into the bark. Almost all of the larval period is spent in the cambium layer of the bark. Winding tunnels packed with frass are characteristic signs of flatheaded borer attack. When the larva reaches maturity it forms an oval cell to pupate. There is a single generation per year, but a considerable overlap of stages occurs.

Injury

The borer commonly attacks weak or injured trees. Young trees are particularly susceptible to attack because of the period of establishment and the possibility of sunburn on the bark. Since the larvae feed in the cambium layer, they can girdle and kill young trees rather quickly. Limbs of older trees may be weakened or entirely killed. The tree is then subject to attack by other pests, such as the shot-hole borer.

Control

Cultural methods of control are usually adequate to prevent attack by the Pacific flatheaded borer. The chances of attack are lessened when the bark of young trees is protected by cardboard or whitewash. Any cultural activity which tends to keep the trees vigorous will aid in preventing borer damage. In areas where native hosts provide an abundant source of infestation, a mixture of DDT wettable powder and whitewash applied to the trunks of young orchard trees seems to prevent an attack.

BRANCH AND TWIG BORER

Another pest with a wide host range is the branch and twig borer, *Polycaon confertus* Lec., which in some years is fairly abundant and can cause commercial apricot damage.

Field Identification

The adult is a slender, brown beetle about $\frac{1}{2}$ inch long. The body is cylindrical and the prothorax, or first body segment, is narrowest at the base. The larvae are not encountered in orchard crops because the beetle breeds elsewhere.

Seasonal Life History

According to Herbert (1920), the beetle does not breed in orchard trees but lays its eggs in the dead wood of a number of native and cultivated trees and shrubs. The larvae bore into the heartwood of the host and feed within this area for a year and possibly longer. Pupation occurs within the wood, and adults emerge in early summer. They often fly to orchard trees where they bore into the small branches. Later in the season the eggs are laid on the various hosts. There is one generation per year, although some larvae may take two seasons to mature.

Injury

Since the adults bore into the smaller

twigs and branches, they can severely prune young trees. The beetle, which does not seem to prefer weak trees, commonly burrows at the axil of a bud or at the fork of two branches. It penetrates for a quarter inch or more and leaves a considerable amount of frass at the entry site (fig. 32). The injured area may be subject to attack by wood-rotting fungi in addition to the weakening of the twig. Pruning is caused by the breaking of the branch at the burrow during windy periods.

Control

As in the case of the Pacific flatheaded borer, control of the branch and twig borer is cultural. Removal and burning of prunings and dead wood in and around the orchards reduce the breeding sites of the beetles. At present there is no chemical means of preventing beetle attack, but infestations rarely reach damaging proportions if care is taken to remove dead wood from the vicinity of the orchard.

Figure 32. Branch and twig borer damage at a bud.





Figure 33. Mature larva of the western peach tree borer.

TRUNK AND ROOT FEEDERS

WESTERN PEACH TREE BORER

The western peach tree borer, *San-ninoidea exitiosa graefi* (Hy. Edw.), is an important pest of stone fruits not only in California but in most of the western United States. Essig (1958) lists peach as the preferred host, but in California it is more commonly associated with apricots. It is also an economically important pest of prune, plum, almond, and peach in the coastal counties.

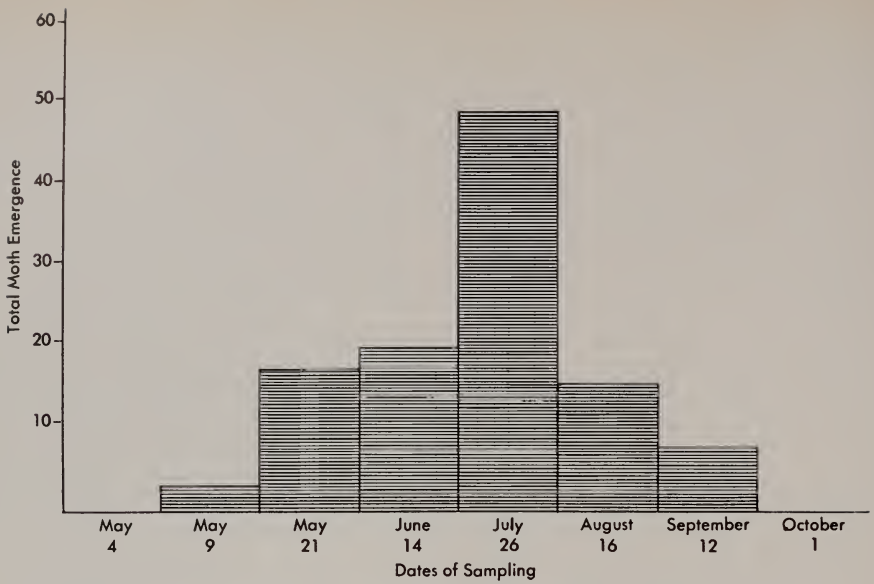
Field Identification

The western peach tree borer belongs to the family Aegeriidae, commonly known as clear winged moths. The female has a wingspread of approximately $\frac{1}{2}$ inch. The forewings are opaque while the hindwings are transparent. The male is slightly smaller, and each forewing has a translucent area near the apex. The body color of both sexes is black to metallic steel-blue. The moths fly rapidly with a

zigzag motion and can be seen during the day when disturbed. The eggs are flat and oval and are laid singly on the trunks of the tree. The larvae burrow within the bark and are not seen unless the outer bark is removed. Mature larvae (fig. 33) are soft bodied, cream to white in color with a brown head and prothoracic shield.

Seasonal Life History

The western peach tree borer has a single generation per year but there is considerable overlap which prolongs the emergence period of the adult. Snapp and Thomson (1943) reported that in the southern states the moths emerge from May to November, with a peak in August and September. King and Morris (1956) have shown that in Texas the moths emerge from late May to October, with a decline in August followed by a peak in September. Madsen and Sanborn (1957) studied the emergence of the peach tree borer in the Brentwood area



Graph 2. Seasonal emergence records of the western peach tree borer in Brentwood, California, 1956.

of California during 1955. It was possible to determine the adult emergence pattern by sampling the pupal cases at the base of infested trees at biweekly intervals. Graph 2 shows the seasonal emergence in 1956. Moth emergence started in May, reached a peak in July, and continued into September.

The borers overwinter as larvae of various ages within the inner bark of the tree. Most of the larvae are found in the area between the soil line and main roots, although some may be found above ground. Pupation takes place in cells constructed of frass and bits of bark (fig. 34). The pupation cells may be found next to the trunk or projecting from cracks in the soil. Adults emerge over a long period of time, mate, and lay their eggs on the trunks of the tree. Upon hatching, the young larvae burrow through the bark to the cambium and then feed within this layer.

Injury

The damage caused by the western peach tree borer is a result of the larvae feeding on the cambium. Girdling of

Figure 34. Pupal case of the peach tree borer.



young trees may take place in a short time, and these are killed. On older trees the borers cause a general weakening of the tree which often results in a loss in quantity and quality of the crop. A persisting infestation can kill even large, mature trees. In most cases older trees will survive several years of attacks before succumbing. Observations by Madsen and Sanborn (1959) indicated that trees which had evidence of prior peach tree borer injury were more susceptible to reinfestation. For this reason, large trees sometimes can be killed in a relatively short time.

Control

Paradichlorobenzene has been the accepted chemical used to control the western peach tree borer for many years and is still useful. Anthon (1955) tested several other fumigants in Washington and found ethylene and propylene dichloride to be effective. Madsen and Bailey (1959) reported the results of experiments on soil fumigation and trunk sprays for control of borers. The fumigation trials involved paradichlorobenzene,

ethylene and propylene dichloride, tetrachloroethane, Vapam, Nemagon, parathion granules and lindane drench. Paradichlorobenzene and propylene dichloride gave the best control. Ethylene dichloride also provided commercial reduction of borer populations. Tetrachloroethane was effective but extremely phytotoxic. The other compounds tested did not give satisfactory results.

Trunk treatments were tried in 1957 and 1958 following earlier screening tests. One of the difficulties involved in evaluating plots was the lack of a suitable method of determining population densities. Caging of tree trunks was tried but did not prove satisfactory. Collecting and counting of pupal cases gave reproducible data, but a year's delay was necessary to finalize results. In the fall, borer attack is characterized by the presence of small areas of frass (fig. 35) on the tree trunk. When winter begins these areas coalesce into large gummy areas (fig. 36). An evaluation of the trunk treatments was obtained by counting the number of frass areas on a tree. The counts were made in September or October before the tree

Figure 35. Frass area on trunk of apricot, indicating attack of western peach tree borer.





Figure 36. Gum area on apricot trunk showing larva of western peach tree borer in cambium.

produced gum and masked the individual entry sites. Of the materials tested as trunk sprays, Thiodan, Dieldrin, and Endrin proved to be the best materials and were most effective when applied at bimonthly intervals. Some of the other compounds gave control but required more frequent applications.

Timing of the first treatment is critical. Observations on emergence over several seasons indicated that mid-May should be the proper period. By smoothing the dirt beneath the trees, pupal case counts can be used to determine the best timing.

One treatment in May and a second in July span the long emergence period of the adults. The residual effect of the insecticides is sufficient to prevent larvae from entering the bark.

No parasites or predators were reared from western peach tree borer during the course of the investigations in California. There was no indication that natural control provides any significant reduction in borer populations. For this reason, it seems that artificial control will have to be relied upon to prevent damage from borer attack.

ACKNOWLEDGMENTS

The authors wish to express their appreciation to all those who contributed time, effort, and materials to the investigations on insects and mites of apricots. A number of growers in Santa Clara and Contra Costa counties helped by donating sections of their orchard for field plots and by providing assistance with equipment and facilities. Several chemical companies also donated pesticides used in experimental trials. Various processing companies contributed to the studies by furnishing processed fruit for analyses, by finding cooperators, and by purchasing orchard fruit for residue and organoleptic tests.

A number of farm advisors provided valuable assistance in the field and particular thanks go to Ross Sanborn, James DeTar, and Lee Benson. University of California personnel who assisted both in the laboratory and field were Stanley Benedict, Robert Clark, J. Blair Bailey, Peter H. Westigard, Louis A. Falcon, Marius S. Washbauer and Stanley C. Hoyt.

A special note of appreciation should go to Arthur D. Borden, Entomologist Emeritus, who initiated much of the research on apricot insects and who directed the program until his retirement in 1953.

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